COMMERCIAL RECEIVERS

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Commercial Receivers

INTRODUCTION

One must not judge receivers used aboard ship, at land stations, or monitor receivers at transmitting stations, by the standards of broadcast receivers used in the home for purposes of entertainment. For example, the loudspeaker which is such an important adjunct to the broadcast receiver is not needed in commercial receivers, as a rule. This simplifies the audio system. Again as the modulation frequencies are limited, greater selectivity is possible and flat response audio amplifiers are not required. Whether the receiver is to be used for short or long waves (above 600 meters) the frequency tuning range required in a single receiver is so great that special tuning extensions of simplified tuning circuits must be used.

Many of the receivers still in use permit the choice of either crystal or vacuum tube detection. Of course where such receivers are still in use, the crystal detector is used only for emergency purposes, just as the spark transmitter is used only in cases of emergency.

Commercial receivers are not subject to rapid obsolescence. Operators are expected to operate any of the receivers whether of new or old design. Their technical knowledge permits them to adapt themselves to all types in use. As few commercial receivers are sold, manufacturers do not change their models often. Regenerative and battery operated receivers are in general used for commercial purposes.

To obtain a clear insight into the design of commercial receivers, and why circuits which on the surface appear to be obsolete are extensively used, we must understand the details of commercial wave reception.

In the first place the commercial wave band extends from 10 kilocycles to approximately 30,000 kilocycles or more, excluding broadcast, emergency, experimental, and amateur frequency allocations. It may be easily seen from this that the broadcast band, which is only 960 kilocycles wide, includes only five or six per cent of the entire radio spectrum, most of which is taken up with commercial work. Then too, in the broadcast band we are

interested only in modulated wave reception whereas in commercial work, continuous waves (C.W.), modulated continuous waves, interrupted continuous waves (I.C.W.), tone modulated continuous waves, alternating current modulated continuous waves (A.C.C.W.), and damped waves are used. Some commercial receivers are made to receive only one type of wave and some can be used for more than one of these types. The type of wave received will not only affect the design of the detector circuit but in most cases the rest of the receiver as well. The regenerative receiver owes its success and popularity to the fact that it can be adjusted for any type of wave and is equally adaptable in one form or another to any frequency in common use.

The requirements and special adaptability of receivers to the various commercial needs is best realized by studying the various receivers in common use.

THE IP 501 RECEIVER

The IP 501 receiver is a single tube, battery operated receiver of the regenerative type. It was originally designed to cover the wavelength range from 300 to 8000 meters and with the addition of a long wave loading unit which will be described later, its wavelength range may be extended to 18,000 meters. Since this receiver is invariably used with an external audio amplifier, the diagram (see Fig. 1) is shown with the two stage transformer coupled amplifier attached.

The antenna circuit of this receiver consists of an antenna coil L_1 made variable in steps by means of taps and switch points, a primary tuning condenser C_1, and a link, the latter for the purpose of supplying additional inductance in the primary circuit for long wave tuning. The secondary or grid circuit of the detector in this receiver consists of three separate coils and a secondary tuning condenser. One of these secondary coils, L_2, serves the purpose of coupling the circuit to the primary for picking up the signal and transferring the signal to the grid of the tube. The secondary coupling coil is mounted on a shaft so that it may be rotated, providing variable coupling between the primary and secondary.

The coil L_3 in the secondary circuit is variable in steps for wavelength selection. Coil L_4 in this circuit is to couple to the tickler coil and is for the purpose of picking up feed-back energy

from the plate of the detector. Note too that a link is also provided here so the secondary may be loaded when longer wavelength reception is desired.

The tickler coil is in two sections one of which is fixed with respect to the secondary coupler coil and the other of which may be rotated to provide variable tickler coupling. In this way, although some amount of feed-back is always obtained, additional feed-back may be obtained for the various wavelengths, and the circuit may be adjusted for the proper degree of regeneration in the tube. A link is also provided for loading. It is essential to have enough coupling and inductance in the plate of the detector so that oscillation may take place when C.W. waves are picked up.

An oscillation test button is provided which simply shorts the tickler coil. If the tube is oscillating, a click will be heard

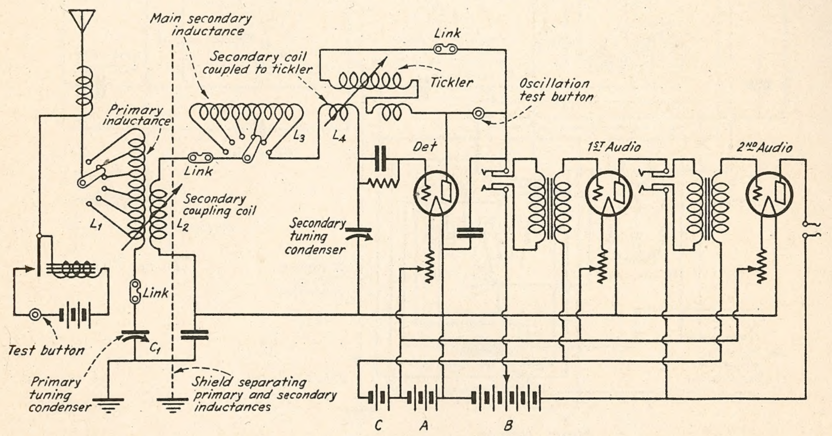


FIG. 1

on pressing the oscillation test button, but if it is not oscillating, no click will be heard. This should be clear when we realize that a grid leak biased oscillator will have less than normal plate current when in oscillation. When the button is pressed, oscillation, if present, will stop, and the plate current will increase sharply giving rise to a click. When no oscillation takes place, there is no current change to cause a click.

It is essential that the antenna, secondary and tickler circuit have no inductive coupling between them except through the coupling coils provided for this purpose. The antenna circuit is

separated from the others by a shield; the secondary is placed at right angles to the tickler system. In this way each circuit may be tuned with the least effect on the other circuits.

The audio amplifier, which in the IP 501 receiver is in a separate container, is of the conventional transformer coupled type. Each tube in the two stage amplifier has its filament controlled by a separate rheostat. A closed circuit jack is provided at the input of the transformers so that the desired signal intensity may be obtained without a volume control and without adjustment of the filament current of the detector, by plugging in the phone at any stage.

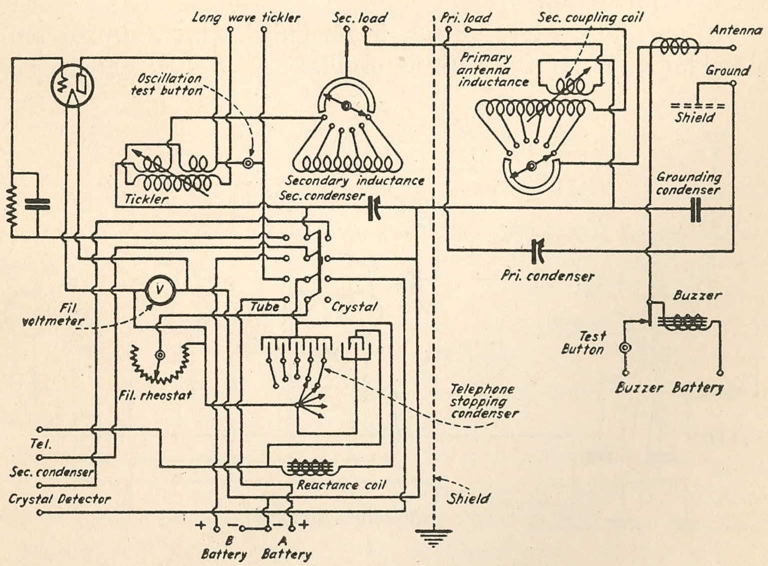


FIG. 2a

Figure 2a shows the IP 501 as it is connected without the audio amplifier. All details are shown. Note that it is equipped to operate with a crystal detector as well as with a tube detector. There is a four pole double throw toggle type switch which, thrown to the "tube" side, will throw into the circuit the tube detector and when placed to the side marked "crystal" will cut the tube out of the circuit and connect the crystal in. The actual connections are best shown by the schematic diagrams in Fig. 2b and Fig. 2c which show connections for tube and crystal respectively.

Observe that in Fig. 2a there are two condensers, one fixed and the other variable, the capacity of the latter being varied by means of the fan type selector switch. The variable capacity is connected between the plate and filament of the detector tube to control the amount of R.F. by-pass, thus giving a control on

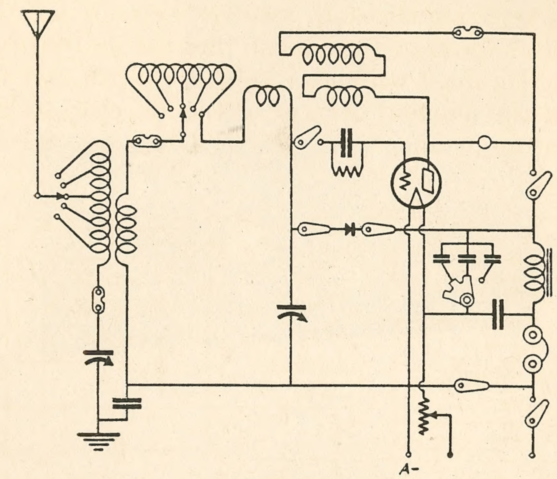


FIG. 2b

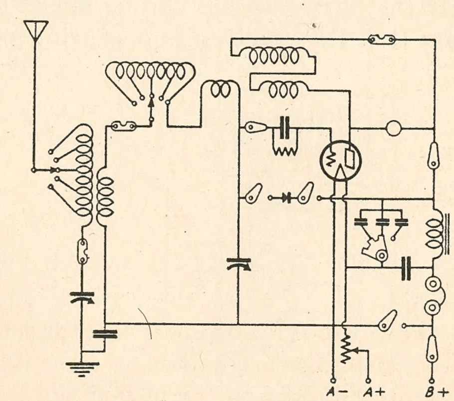
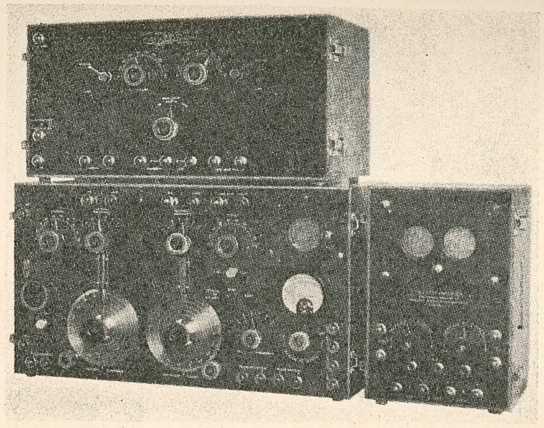


FIG. 2c

the amount of background noise and a secondary control on regeneration. The fixed condenser and the iron core choke form the output filter circuit.

Figures 1 and 2a show the test buzzer coupled to the antenna circuit for testing the operating condition of the receiver, espe-

cially when the crystal detector is used. A capacity coupling is used, created by winding only a few turns of wire from the buzzer around the lead-in wire. The insulation is not removed



Courtesy Duncan and Drew

FIG. 3

from either lead wire, thus giving only a small amount of capacitive coupling. If the buzzer signal can be heard loud and clear, it is an indication that the receiver is operating properly.

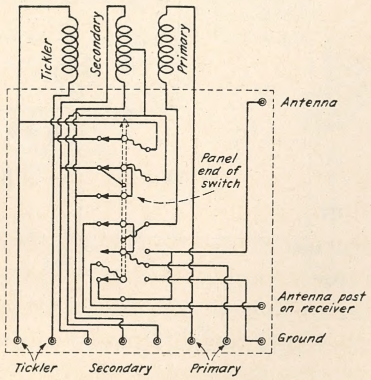
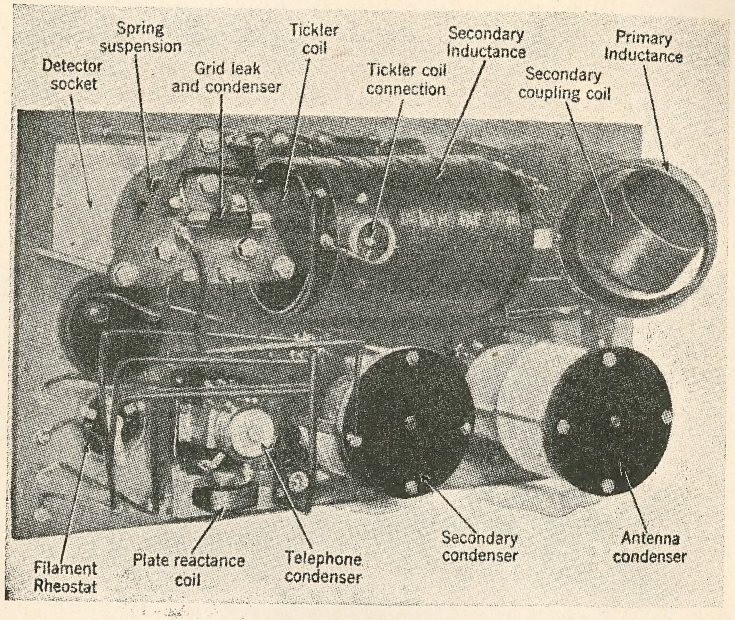


FIG. 4

Referring to Fig. 3, it will be observed that the IP 501 is shown to the lower left, the audio amplifier to the right, and mounted directly above the receiver proper is the loading coil

system. The three links shown in Fig. 1 which connect the three sets of binding posts on the IP 501 receiver are opened and connections are made to the six binding posts on the loading coil container. The internal connections of the loading unit are given in Fig. 4. These permit the loading coil to be used at two loading values or to be taken out completely.

The internal arrangement of parts of the IP 501 is shown in Fig. 5.



Courtesy Duncan and Drew

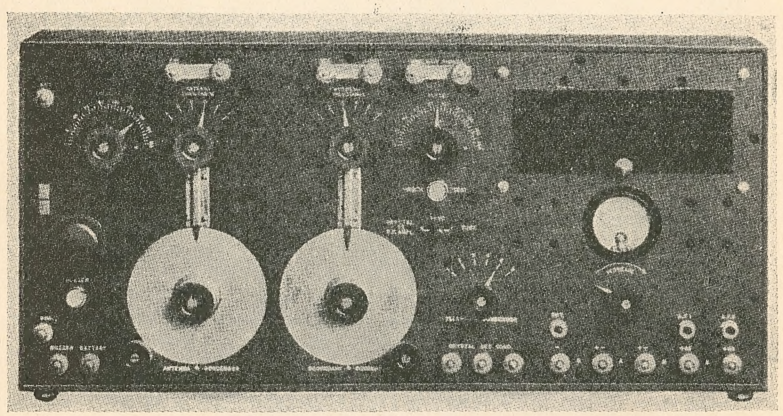
FIG. 5

At the right of the receiver panel are placed binding posts for connection to the headphones or the amplifier and provision is made for the external connection of the crystal detector.

The antenna and ground binding posts are on the left of the panel and on the bottom of the panel are the buzzer battery binding posts and the plate and filament binding posts. The terminals are clearly marked and polarity is shown where necessary.

The antenna and secondary inductance switches are provided with cams which automatically raise and lower the dial pointer for wavelength calibration on the dial corresponding to the amount of inductance included in these circuits.

To adjust the receiver and operate it to receive continuous waves, proceed as follows: Throw the toggle control switch to "audion" position and advance the filament rheostat until the voltmeter reads five volts. Set the tickler pointer at an approximately vertical position and set the telephone condenser switch to point *3* or *4*. Listen in with the headphone and test for oscillation with the oscillation test button as mentioned. Now set the antenna coupling switch approximately to point *80* on its scale and adjust the antenna and secondary inductances to the desired wavelength as indicated on the main tuning dial. Tune the antenna and secondary condenser until the desired station is received and reduce the tickler coupling as much as possible for clear and sensitive reception. The primary to secondary coupling should also be reduced as much as possible for selective reception.



Courtesy Duncan and Drew

Fig. 6

This variable coupling arrangement enables the operator to tune broadly or sharply as desired. When listening in, that is, when using the circuit as a standby circuit, coupling should be tight. When working in traffic, coupling should be loose for minimum interference. When standing by, tight coupling enables the operator to hear signals over a wide range of frequencies.

For the reception of damped waves, modulated continuous waves, or interrupted continuous waves, the same procedure is followed except that the tickler coupling is further reduced and the telephone condenser pointer is set on lower values until the proper regenerative action of the detector circuit is obtained.

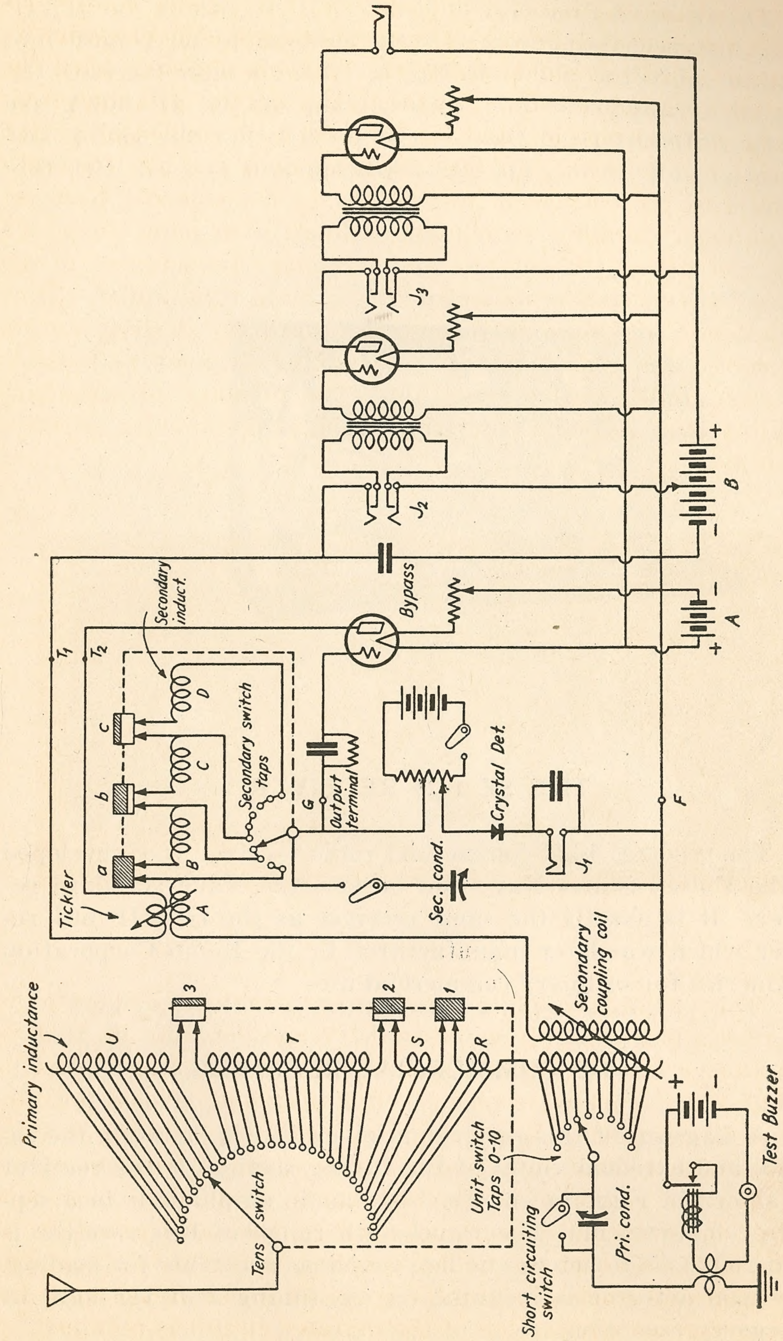
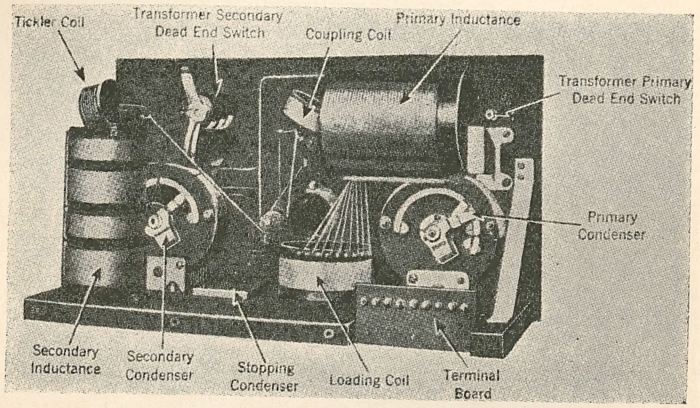


Fig. 7

The IP 501A Commercial Receiver is essentially like the IP 501 as just described except that the audio amplifier is built into the same cabinet as shown in Fig. 6. Being a later receiver, the internal arrangement and construction of the IP 501A are slightly different from that of the IP 501, but the action and control are identical. The same loading unit is used with this receiver.



Courtesy Duncan and Drew

FIG. 8a

THE SE 1420 RECEIVER

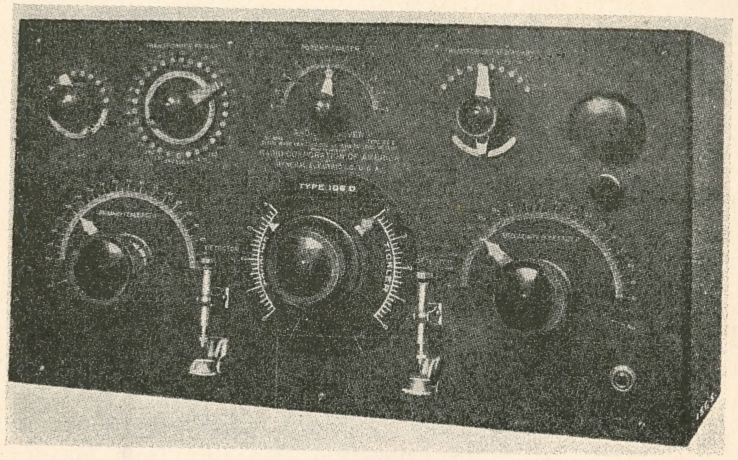
The type SE 1420 commercial radio receiver was developed by the United States Navy and became the Navy standard receiver. It is exactly the same receiver as the type IP 501 receiver which was later manufactured by the Radio Corporation of America for ordinary commercial use.

106-D COMMERCIAL RECEIVER

A diagram of this receiver is given in Fig. 7, while the internal and external views of the tuning section of the receiver are shown in Figs. 8a and 8b. The audio amplifier is in a separate compartment. The wavelength range of this receiver is from 200 to 3500 meters and no provisions are made for loading. A crystal detector is mounted on the tuning unit for local or emergency reception.

The primary or antenna circuit consists of two coils in series, a series variable condenser and a buzzer pick-up loop. The second of these coils mentioned, as will be seen from the diagram, is simply to load the antenna circuit for the wavelength to be received. The coils are connected in a very unique manner so that the unused portion of either coil can be eliminated from the circuit entirely.

In a circuit containing a large amount of inductance, if it is desired to vary this inductance from maximum to minimum values, ordinarily there would be a great deal of the coil attached to the active circuit and yet not forming a part of it, when adjustment is made to use a small amount of this inductance. This



Courtesy Duncan and Drew

FIG. 8b

is a very undesirable condition as the inductance remaining connected to the active part of the circuit will affect the intensity of reception and lead to signal interference.

The presence of extra turns on the coil coupled inductively and by conduction, leads to what is termed "dead end" effect. These extra turns have distributed capacity and together with the inductance of the turns constitute a resonant circuit. This oscillatory circuit will absorb energy from the active circuit with the result that the signal intensity of the desired signal will be reduced and the sharpness of tuning greatly impaired. It is therefore essential that the unused portions of the coil be dis-

connected from the active turns and this section in itself be broken up as much as possible. The positions of the breaks were obtained by experiment when the original design was made.

In the 106-D receiver the primary is made in two sections; ten turns of wire with taps from 0 to 10 turns, the taps connected to a ten point selector switch, and a large coil integral with the unit tap coil with taps taken off at every ten turns, which too are taken to a multi-tap selector switch. The main inductance is opened at predetermined points which must be bridged when the extra turns are to be included.

A cam switch operating in conjunction with the tap switch in the antenna circuit serves to disconnect various portions of this load inductance when they are not in use. For example, when the switch marked *"tens switch"* is brought in contact with any tap on coil *U*, cam *3* is rotated so that coils *U* and *T* will be connected together, cam *2* is rotated so that coils *T* and *S* will be connected together and cam *1* connects coils *S* and *R*. When the tens switch is adjusted on any tap for coil *T*, cam No. *3* disconnects coils *U* and *T*, and when the tens switch is adjusted at any point on coil *S*, cam *2* will disconnect coil *T* from coil *S* and so on. The shaft of the switch drives the cam and so this connecting and disconnecting of the coils is done automatically.

The loading section of the primary is placed on a separate coil form and placed as shown in Fig. 8a, so that there is no coupling with the main primary turns. This reduces the absorption of the disconnected coil. A coupling coil which turns through 90 degrees is placed at the end of the main primary inductance where the unit turns are situated, thus maintaining normal coupling control regardless of the loading. The coupler is rotated by a knob in the lower center of the panel, and mechanically by a lever. The actual knob is a two-deck affair, one to control the primary to secondary coupling and the other to control the regenerative tickler coil.

In tuning the low range of wavelengths, the primary series variable condenser is used. When not in use it is brought back to the point below zero on the dial marked "out" and the condenser is automatically short circuited.

In addition to this secondary coupling coil the secondary circuit consists of a multiple inductance similar to the primary inductance just described and a secondary tuning condenser. To one section of this multiple coil for the secondary a tickler coil

is coupled. The tickler coil can be rotated with respect to the secondary so that variable coupling may be obtained.

The detector is in a separate compartment, together with the two stage transformer coupled amplifier. Connection between the detector-amplifier and tuner is made from the rear terminal boards of the units. Schematically the connections between the units are shown in Fig. 7 by terminals T_1, T_2, G and F.

When the crystal detector is to be used, the detector-amplifier power supply is turned off and the crystal-phone terminal is then not shunted by the grid input load of the regenerative detector. A special potentiometer is then adjusted thus feeding a series voltage to the crystal circuit; the phone plug is inserted in J_1 and the set is tuned for spark or modulated waves. The buzzer coupled to the antenna lead may be used to select a sensitive spot on the crystal.

Before considering the operation of the receiver, let us consider the controls of the receiver shown in Fig. 8b. At the upper left is the unit turn switch of the primary. To its right is the "tens" turn switch. In the upper center is the potentiometer to control the crystal bias. To its right is the secondary loading control. In the lower center is the twin knob control, one for the tickler, the other for the crystal detectors. At the lower left is the primary variable condenser; to the left is the secondary tuning condenser. The phone jack to the right is for crystal reception. Note the buzzer and buzzer button above the phone jack for test purposes.

To operate this receiver close the filament circuit by closing the switches on the attachment or adapter provided with the receiver (not shown) and adjust the three tap switches on the upper portion of the panel for reception of the wavelength desired. Experience in operating will show just which taps correspond to certain stations the signals of which are desired. A tuning log for various wavelengths should be kept. Adjust the antenna coupling coil to about *2* on its scale and vary the tickler adjustments until the critical point of regeneration is found. By moving the tickler pointer past this point several times, the critical point of regeneration can easily be located as a click or thump will be heard in the headphones or speaker.

Now if you desire to receive any type of modulated signals such as damped waves, interrupted continuous waves, or voice modulated waves, adjust the tickler for the least regeneration required to give a good signal. For continuous wave reception

adjust the tickler for oscillation. Here again experience will enable the operator to determine whether or not the detector tube is oscillating. This can usually be determined from the sound produced in the headphone or speaker. Selective reception is obtained by decreasing the coupling between the primary and secondary. In this case a slight readjustment of the variable condensers may be necessary.

When the receiver is not in use, both of the condenser pointers should be moved to the position marked "out" which disconnects the secondary condenser from the circuit and shorts the primary condenser as explained previously. This is for protection of the set.

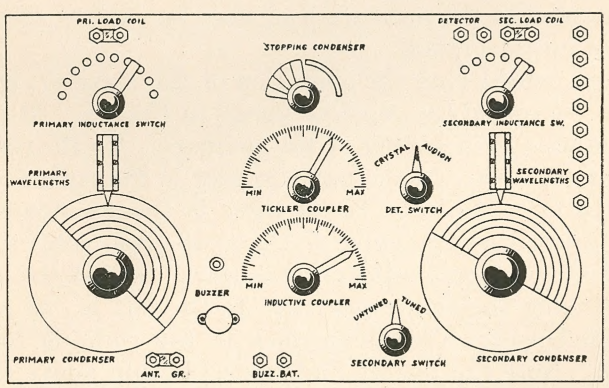


FIG. 9

NAVY TYPE SE 143 RECEIVER

The general panel arrangement of this receiver is shown in Fig. 9. It has a tuning range of 250 to 6400 meters and it employs an external crystal detector or regenerative detector with audio amplifier. A diagram of the tuner is given in Fig. 10.

The antenna circuit of this receiver includes a three section primary coil, a link for loading the antenna circuit, and a primary tuning capacity. The coil and condenser tuning system of the primary and also of the secondary is similar mechanically to that of the type IP 501A receiver. Most of the antenna coil is used for tuning whereas the rest of it is used for coupling to the secondary coil. The primary, secondary and tickler coils are mutually coupled. Any section of the primary circuit coil which

is not in use is automatically cut completely out of the circuit. In series with the secondary circuit is a link to provide additional load where necessary and an additional untuned secondary coil may be placed in series with the secondary circuit by means of a double pole double throw switch.

Referring to the picture of the front panel of this receiver, shown in Fig. 9, it may be seen that the primary tuning condenser is at the lower left of the panel and the secondary dial at the lower right. Above the first mentioned is the primary inductance switch with ten taps; and above the second mentioned is the secondary inductance switch with six taps. In the

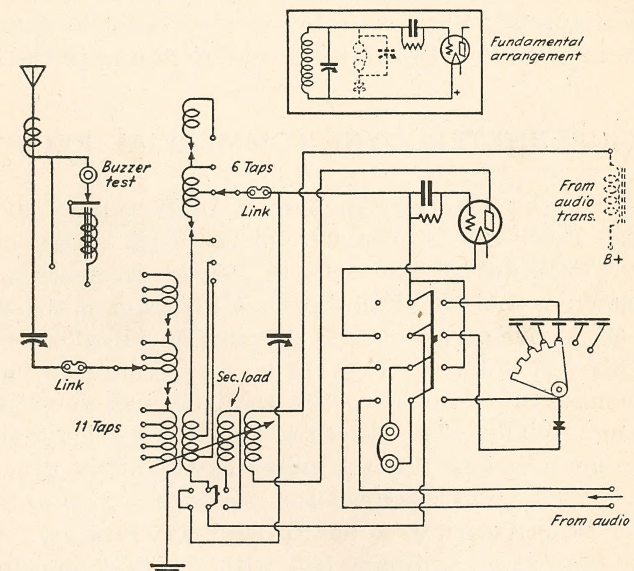


FIG. 10

center of the panel from top to bottom are the stopping condenser fan switch, the tickler control and the primary and secondary coupling control. Antenna and ground connections are shown along the bottom of the panel and connections for coupling to an audio amplifier system are to the upper right of the panel. As in the case of the other receivers mentioned, the links on this one can be removed for additional load and may be connected to the binding posts at the top of the panel.

When it is desired to receive modulated signals, either the crystal detector or the vacuum tube detector may be used. If the

crystal detector is used, which is preferred for spark reception, the detector switch must be set on the crystal position and the secondary switch in the untuned position. The inductive coupler is set at maximum and the detector is adjusted to a set position by means of signals from the local buzzer.

The wavelength adjustment may now be made for the desired stations. The secondary switch must be thrown to the tuned position before a station is tuned in. If it is desired to use the vacuum tube for spark reception, it is only necessary to throw the detector switch to "audion" position.

For the reception of continuous waves, the tube of course must be used. Set the inductive coupler at approximately 50 and vary the tickler coupler until good oscillation is obtained in the secondary circuit. Proceed as usual by tuning in the station.

THE SUPERHETERODYNE COMMERCIAL RECEIVER

The Western Electric Company manufactures four superheterodyne receivers for commercial use with model numbers 6004-A, 6004-B, 6004-C and 6004-D. These receivers are commonly known as 4A, 4B, 4C and 4D. A diagram of the Western Electric 4C superheterodyne is shown in Fig. 11. The other circuits mentioned differ basically in no way from this one; only minor changes were made as the receiver was developed and tested commercially. The circuit of the 4C superheterodyne receiver is shown because it is the most common of the group.

The receiver was designed for use with a loop antenna of the center tapped variety to obtain loop regeneration. Considering the loop as an ordinary coil with the first detector tube, the circuit resembles a Hartley oscillator circuit. This is known as a Rice loop after its inventor.

The oscillator tube, which is the first one to the left in the diagram, feeds energy into the grid coil of the second tube which of course is the mixer-detector tube required before the intermediate frequency amplifier.

The oscillator and grid pickup circuits are on a coil unit which enables the receiver to cover the active commercial wave band.

The oscillator frequency differs from the signal frequency by 45 kilocycles which is the intermediate frequency. The antenna and oscillator tuning condensers are not ganged together

but the loop antenna and the grid and plate coils of the oscillator plug-in unit are so made that at the same setting for each condenser dial, the signal and oscillator frequencies will differ by 45 kilocycles. The first detector (bias type; second tube from left) is followed by two intermediate amplifier stages which in turn are followed by a second detector using grid detection. A single stage audio amplifier completes the receiving system.

In the plate circuit of the first detector tube, a potentiometer with suitable taps is provided for volume control in five steps.

Closed circuit jacks are in the oscillator and first detector plate circuits for testing and determining the plate current flow of these two tubes.

A cut-out switch is supplied between the first and second intermediate amplifier tubes for the purpose of cutting out the

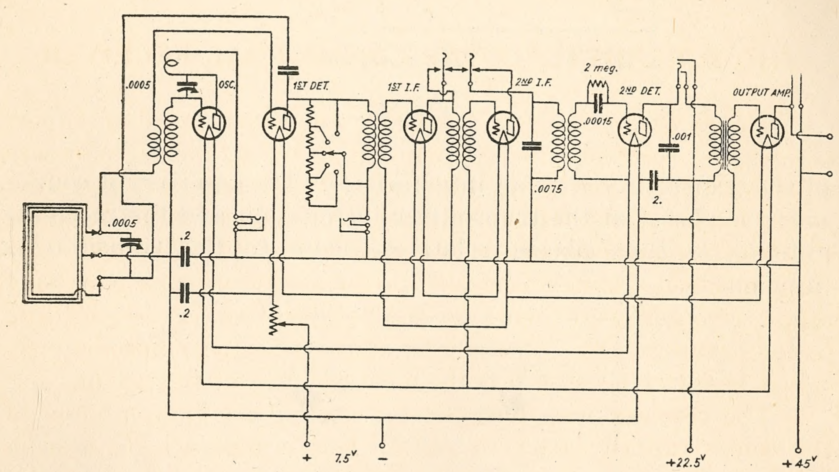


FIG. 11

second intermediate frequency amplifier in order to reduce the gain of the receiver on local reception or where high gain is not desired.

The tubes are Western Electric type 215A (peanut tubes), requiring but 1.1 volts for their filaments. These filaments are connected in series and the grid bias for the various tubes is obtained from various points in the filament circuit.

An output jack is provided directly at the second detector and, of course, in the plate circuit of the output tube. Two additional terminals are provided for connection to a power amplifier when this is desired.

The greatest use of this receiver is in commercial shore stations where a commercial watch on the 600 meter wave is demanded.* With the proper auxiliary equipment, the receiver may be operated simultaneously within 10% of the frequency

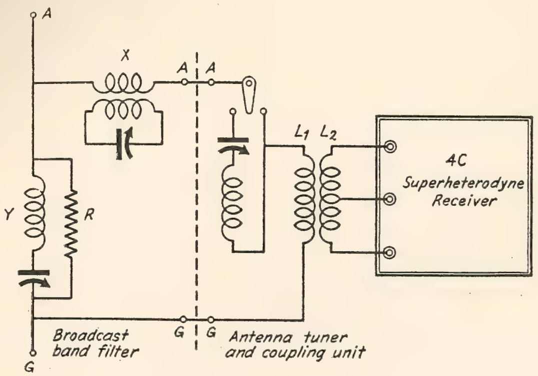


FIG. 12

of the transmitter without interference. The receiver, of course, must be placed at the transmitter installation and the receiving antenna is thus placed relatively close to the transmitting antenna.

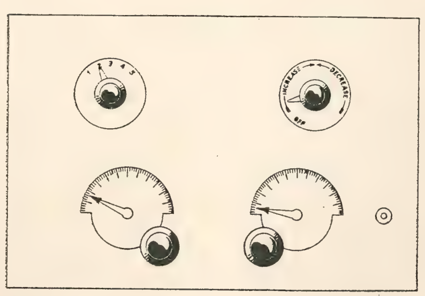


FIG. 13

A filter (wave trap) and antenna tuning unit—see Fig. 12—are provided when this receiver is used for commercial watch in a broadcast station on an external aerial.

As shown in Fig. 12, the broadcast band elimination filter unit consists of a series section and a parallel section labelled

*Until quite recently certain broadcast stations were required to keep watch on the commercial wave band but this is no longer required by law.

X and Y respectively. Both of the associated filter circuits are tuned to the frequency of the local transmitter, the series unit X offering very high impedance to the frequency and the shunt unit Y offering a very low impedance to the frequency. The former tends to prevent the signals from entering the antenna post of the superheterodyne receiver and the latter tends to short the signals to ground. A resister R is used in shunt with the unit Y to make its tuning effect broad.

An antenna tuning unit is necessary so that the antenna may be tuned to resonance with the received signal for highest signal efficiency. A switch is provided so that tuning may be optional.

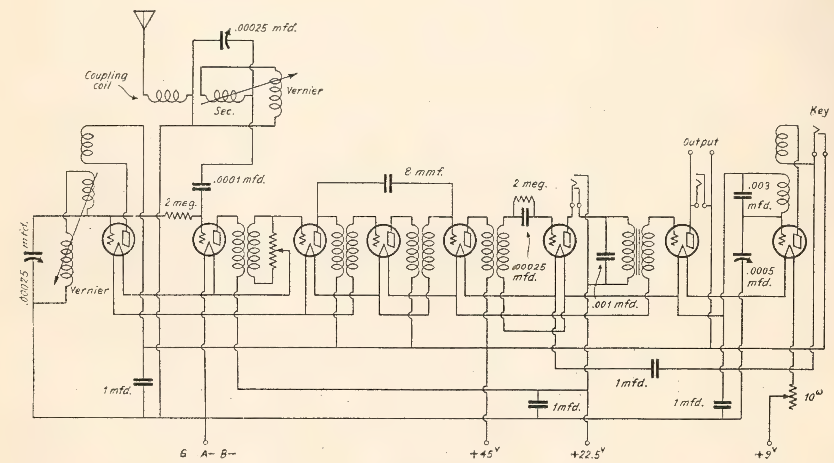


FIG. 14

The loop is removed from the receiver and a coil L_2 is substituted. Energy from the coil L_1, which of course is the primary, is induced into L_2 and thus the signals are introduced into the receiver. An external view of the receiver is shown in Fig. 13.

THE COAST GUARD SUPERHETERODYNE RECEIVER MODEL CGR-1A

The Coast Guard CGR-1A receiver has a tuning range of from 1500 to 3000 kilocycles. Its circuit diagram is shown in Fig. 14.

The antenna system of this receiver is quite simple, consisting of a single antenna coil inductively coupled to a stationary section of the secondary coil. A vernier section of this secondary coil aids in varying the coupling between the primary and secondary and also in regulating the amount of inductance in the secondary circuit. The secondary circuit is tuned by means of a .00025 mfd. variable condenser.

As will be seen, the oscillator tuning system is similar to the antenna resonant circuit. The plate coil of the oscillator replaces the antenna coil of the detector tube and the secondary of the oscillator is identical to the grid circuit of the first detector.

Coupling between the oscillator and first detector tube is established by direct grid connection through a 2 megohm resistor. This resistor also acts as the grid leak of the first detector tube.

The output of the first detector feeds into a three stage capacity neutralized intermediate frequency amplifier which in turn feeds into another grid leak type detector. This is followed by a single audio stage.

Volume is controlled by means of a potentiometer shunted across the secondary of the first intermediate frequency transformer.

An oscillator is provided for continuous wave reception to form a beat frequency with the intermediate frequency. The oscillator is inductively coupled to the second detector grid circuit. A key switch is provided so that the oscillator may be used at any time desired. Of course, this oscillator would not be desired for any reception except continuous wave reception. For this reason, the key is normally open.

COMMERCIAL SHORT WAVE RECEIVERS

The National short wave receiver has come into commercial use quite extensively for high frequency commercial work. Wave bands of 9 to 200 meters which cannot be covered by the receivers previously described can be adequately covered by the National three tube battery or A.C. operated receiver with its associated plug-in coils.

A diagram of the National A.C.-D.C. model receiver is shown in Fig. 15.

The antenna circuit includes one coil L_5 which is inductively coupled to the grid coil L_1 and a resonator circuit L_3. The resonator circuit furnishes a method of tuning the antenna circuit and at the same time couples the antenna to the grid circuit of the R.F. amplifier tube.

Condensers C_1 and C_2 are ganged with an insulating shaft coupling. Notice that both of them are not connected across the entire grid coil, but at a point approximately at the center of the coil.

In this way a high C to L ratio is obtained and by auto-transformer action a large amount of grid excitation is also obtained.

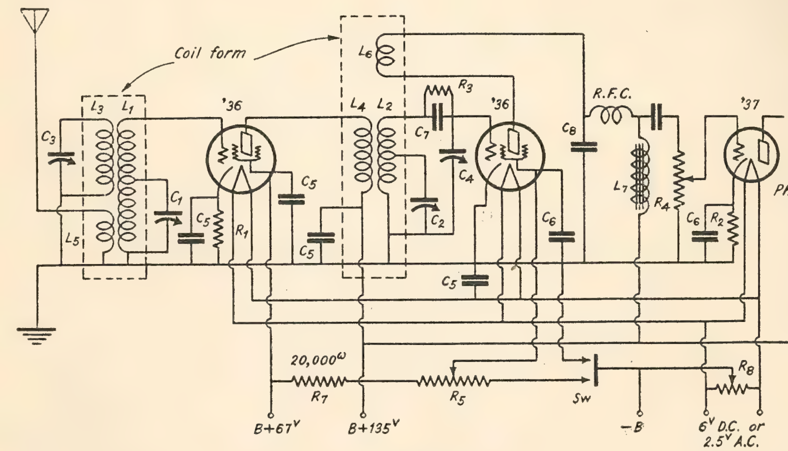


FIG. 15

Aside from these points, the R.F. circuit is of the conventional screen grid type and is inductively coupled to the regenerative detector circuit.

The regenerative detector circuit is of the conventional form employing a plate circuit tickler feed-back system using a screen grid tube and making use of screen grid voltage regeneration control. Condenser C_4 connected between the grid and cathode of the detector tube is a trimmer condenser for band spreading on the high frequencies. The value of this capacity is 8 mmfd.

The tickler coil L_6 is a rather high inductance and the capacity C_8 is fairly low so that reasonably flat regeneration characteristics can be obtained.

The detector plate circuit is series-fed through a very high inductance L_7 and a radio frequency choke *RFC*.

Since it is not practicable to control volume with the regeneration control because of the characteristics of the detector circuit, volume is controlled at the input of the single audio amplifier. A 500,000 ohm potentiometer R_4 is connected in the grid circuit as shown, for volume control. This control in no way affects the performance of the detector circuit. When set at one point for a definite condition of regeneration or oscillation, the circuit remains operating in this condition for any volume desired.

The automobile type of tube is used throughout in this receiver. A type '36 tube is used for the R.F. amplifier and detector, and a type '37 as the audio amplifier.

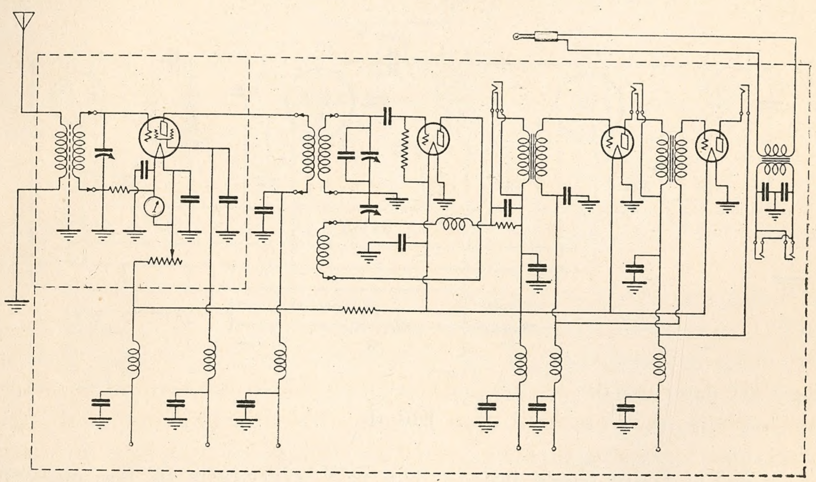


Fig. 16

The switch *SW* breaks the negative B supply lead as well as the potentiometer return circuit so that the plate circuits of all tubes may be instantly cut off and there is no battery current drain through resistors R_7 and R_5. Reception may thus be instantly started and cut off without disturbing the filament circuit. This is an important factor in commercial communication.

RCA-AR1496B SHORT WAVE RECEIVER

This receiver is designed to meet the present needs for commercial reception in the 4000 to 25,000 kc. band. The dia-

gram of the receiver is given in Fig. 16 while the external view is shown in Fig. 17. The receiver circuit basically consists of a tuned stage of R.F. amplification followed by a regenerative detector and two stages of audio amplification.

A type '22 tube is employed in the R.F. stage, a '40 tube as the detector and two type '01A tubes in the audio section. Thus the set may be operated from a 6 volt filament source. A type 841 tube may be used in the detector and type '10 tubes in the audio amplifier with increased ruggedness and signal strength, but at the cost of a larger power supply. A rheostat controls the filament voltage applied to the '22 tubes which is gauged by the built-in voltmeter. The other tubes have their filament voltages limited by a fixed resistor in series with the filament supply.

As a screen grid tube is used in the R.F. system, neutralization requirements are eliminated. Feed-back is accomplished in

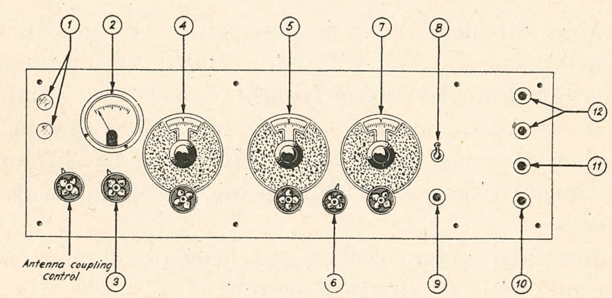


Fig. 17

the detector by the use of a fixed tickler and a variable by-pass condenser. All filament and B supply leads are properly bypassed and choked to keep the R.F. and A.F. currents in their proper circuits.

Shields divide the set into three compartments. In the first compartment is the antenna coil used to couple the antenna to the grid coil of the R.F. stage. The coupling is made through a hole in the electrostatic shield between the first two compartments. The second compartment contains the R.F. tube and its control rheostat, the fixed bias resistor, variable condenser and the R.F. tuning coil, and the required by-pass condensers. The '22 tube is electrostatically shielded within the compartment by a cylindrical copper can. The detector and audio system are in the third compartment.

Several sets of plug-in coils are supplied, each set consisting of one plug-in coil for the R.F. stage and one combination

plug-in coil system containing the R.F. plate coil, the tuned grid coil and the properly coupled tickler coil. The fixed antenna is aperiodic and is satisfactory for all frequency ranges. To insert the two coils, swing open the receiver cover, remove the coils in the set and insert the coils for the desired frequency range.

The front panel contains: (1) the antenna and ground binding posts, (2) filament voltmeter, (3) rheostat to control the '22 filament voltage, (4) R.F. tuning control, (5) detector tuning control, (6) a vernier control for detector tuning, (7) regeneration control, (8) filament switch, (9) detector phone jack, (10) first audio phone jack, (11) second audio phone jack, (12) two output jacks for external speaker or amplifier needs. All power supply terminals are at the rear of the cabinet.

THE MARCONI AUTO-ALARM

The Marconi auto-alarm is used quite frequently to maintain a continuous distress watch on board many vessels. All necessary communications for freight vessels and small passenger vessels can be taken care of in a few hours operating time. It would therefore not be economically sound to employ two or three operators to keep a continuous night and day watch on the distress wave.

An automatic alarm device has been developed which will replace an operator on distress watch.

The complete auto-alarm system consists of a fairly sensitive receiver tuned to the distress wave and a selector mechanism which automatically actuates the relay of a bell alarm circuit upon reception of a distress signal by the receiver.

For reception of distress signals with the auto-alarm system, the conventional S.O.S. signal is not used because of the probability of variation in the manner of sending this signal by various operators. Automatic transmitter equipment need not be used.

A signal consisting of twelve dashes, each having a duration of four seconds and separated by an interval of one second has been found most satisfactory for actuating the auto-alarm selector system.

As in Fig. 18, the receiver consists of a regenerative detector, fixed-tuned to the 600 meter (500 kc.) wave. This is followed by a transformer coupled audio amplifier which in turn is tuned-impedance coupled to the output relay control tube. The

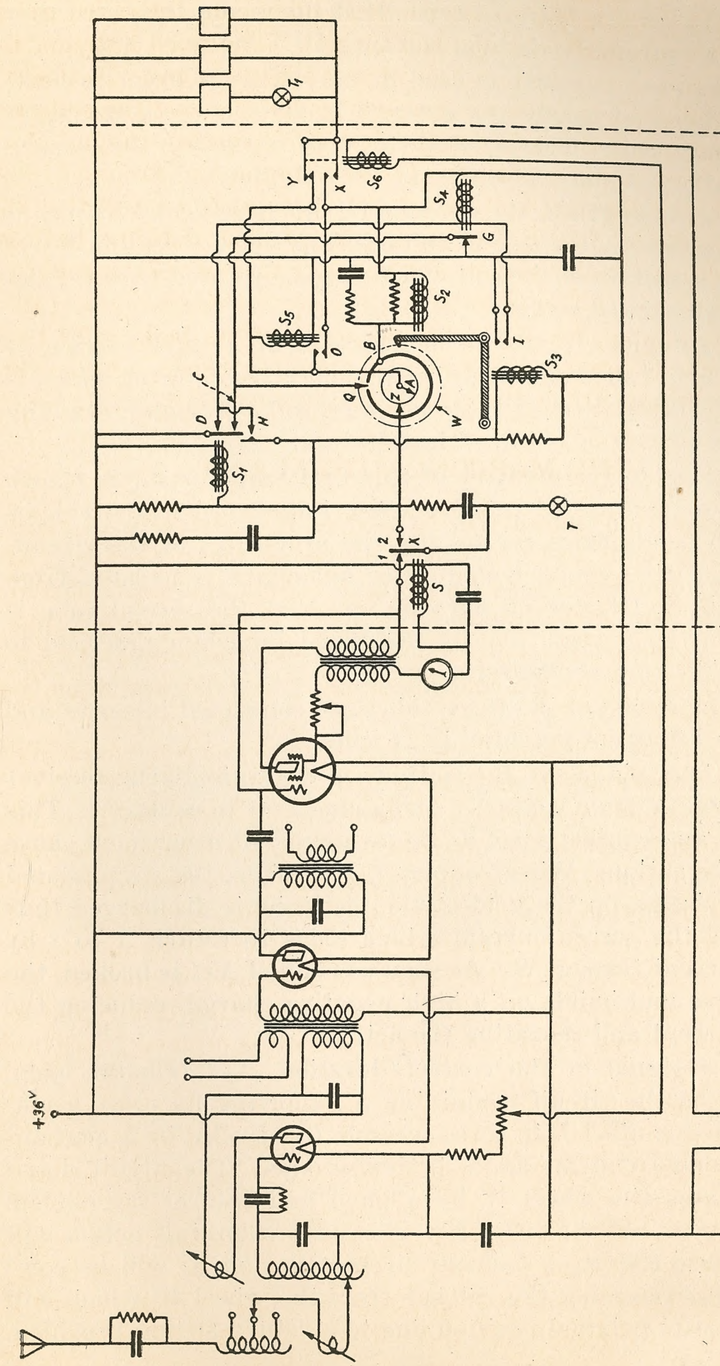


Fig. 18

first two tubes are Marconi type DER tubes and the third tube which is a four electrode tube is a type DE7 Marconi tube.

An antenna capacity is used in the circuit in order to make the impedance of nearly any antenna in present use suitable for the primary coil. This is shunted with a resistor to prevent accumulation of static charges on the antenna.

The wavelength in the antenna circuit is adjusted by means of taps on the main antenna coil and fine vernier tuning is obtained by a section of the coil which may be rotated with respect to the fixed tapped section.

The antenna circuit consists further of a small section of the main grid tuned circuit in the regenerative detector which is simply a continuation of the secondary coil. Variable coupling to the circuit can be obtained in this way.

Adjacent to the primary of this first transformer is shown an isolated winding of relatively low impedance which can be used with headphones for testing the properties of the circuit. Notice that the second transformer secondary is isolated from the circuit for this same purpose and that the second tube is coupled to the output tube by the tuned impedance method to the grid blocking condenser.

The filaments of the three tubes are connected in series and the applied filament potential is 24 volts.

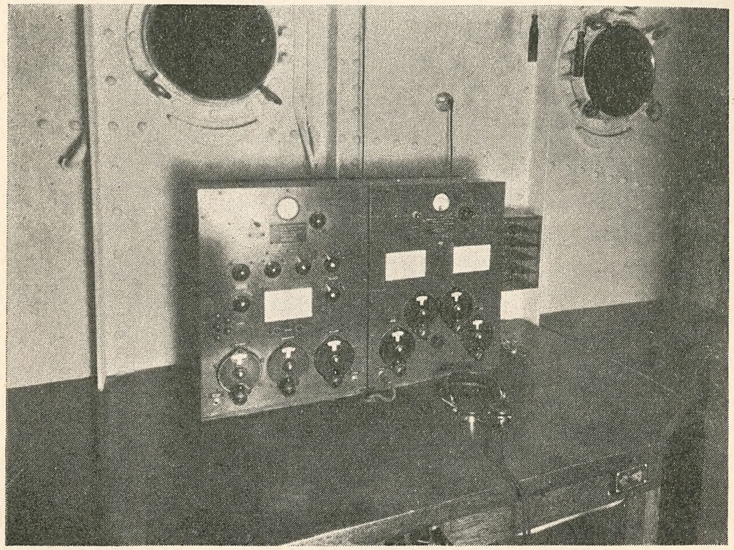
The first signal at the output of the auto-alarm receiver pulls tongue X from contact *2* and connects it to contact *1*. This tongue X and contact *1* act as the armature of a buzzer because of the tube action. When contact X-*1* is made, the accumulated negative charge on the grid of the last tube is discharged thus increasing the screen current which tends to return X to *2* by screen current through S. As soon as contact X-*1* is broken, the grid is free and builds up a high negative charge, reducing the screen current and repeating the action.

For a signal of the correct duration, X-*2* remains open, which opens the circuit containing S_1, allowing its relay armature to close contact D in three seconds (controlled by a mechanical time delay system) and C in five seconds. The circuit closed by D rotates the wheel W by a pawl and ratchet mechanism (driving gear not shown). If C closes too soon, this action will stop because the reset solenoid circuits S_2 and S_3 will be completed, thus releasing the ratchet from the wheel W which will fly back to its original position due to a return spring provided.

Contact Q which is closed only after the wheel is started supports the wheel action and replaces relay G only while in motion because G is opened by S_4 through contact D.

The main bell circuits are completed through Y, S_5, A, Z, *2*, X, T and ground when rotation of the wheel connects A to Z. S_5 however, closes O which completes the bell circuit although A-Z as well as X-*2* may be opened which is the case when the signals cease.

Contacts H and I are simply holding circuits to prevent actuation of the apparatus on false signals or accidental combination of waves forming signals almost equivalent to the alarm signal.



Radio Operating Desk Aboard a Ship

The galvanometer must read between 18 and 20 at all times.

A test button T (closed circuit) may be used to test the apparatus for continuity of the main bell circuit when no signal is being received. Solenoid S_6 actuates the alarm bells when the filament current becomes subnormal as a protection against failure of operation of the receiver.

Since the auto-alarm signal consists of dashes having a duration of four seconds each and being spaced by one second each, it may be clearly seen that the entire signal requires a time of one minute to transmit.

The adjustment of the auto-alarm allows considerable latitude for errors according to the following limits:

1. It will accept a dash as intended to have a duration of four seconds if it continues for more than three seconds and less than five seconds.

2. It will accept a space as being intended to have a duration of one second so long as it continues for more than 1/5 of a second and less than two seconds.

3. It will operate at the end of the third consecutive dash accepted provided that it also accepts the intervening spaces.

4. Each dash and space are joined by the selector mechanism individually.

Within these limits, any operator can send such a signal manually. More than a 66% error is accounted for in the duration of the dashes and approximately a 400% error in the duration of the intervals. Furthermore, it does not matter if all the dashes and spaces included in these percentages are too long or too short or a combination of either.

The auto-alarm has another advantage and that is, after any error in transmission, the selector mechanism returns to its normal starting position at which time the correct signal may be sent immediately. Thus even if an operator makes his first nine dashes incorrect but gets the last three correct, the mechanism will operate the alarm bells. It is hardly possible that this amount of error could be introduced.

TEST QUESTIONS

Be sure to number your Answer Sheet 12CA.

Place your Student Number on every Answer Sheet.

Never hold up one set of lesson answers until you have another ready to send in. Send each lesson in by itself before you start on the next lesson. In this way we will be able to work together much more closely, you'll get more out of your Course, and the best possible lesson service.

1. Name two advantages of the regenerative type of receiver as applied to the commercial field.
2. How is "dead-end" effect overcome in wide-range tuning circuits?
3. What type of waves will the Western Electric 4C receiver in Fig. 11 receive?
4. What circuits must be "loaded" in the IP 501 receiver to enable it to tune to very long waves?
5. What is the purpose of the apparatus shown in Fig. 12?
6. Why is a double contact switch *SW* used in the National short wave receiver (Fig. 15)?
7. How is it possible to receive continuous waves with a CGR-1-A receiver (see Fig. 14)?
8. When standing by, should the primary to secondary coupling be loose or tight?
9. How is a wide tuning range obtained with the RCA-AR1496B receiver?
10. Describe the signal required to actuate the Marconi auto-alarm.